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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A61B 8/00, H03M 7/30	A1	(11) International Publication Number: WO 97/09930 (43) International Publication Date: 20 March 1997 (20.03.97)

(21) International Application Number: PCT/KR96/00157

(22) International Filing Date: 11 September 1996 (11.09.96)

(30) Priority Data:
1995/29911 13 September 1995 (13.09.95) KR

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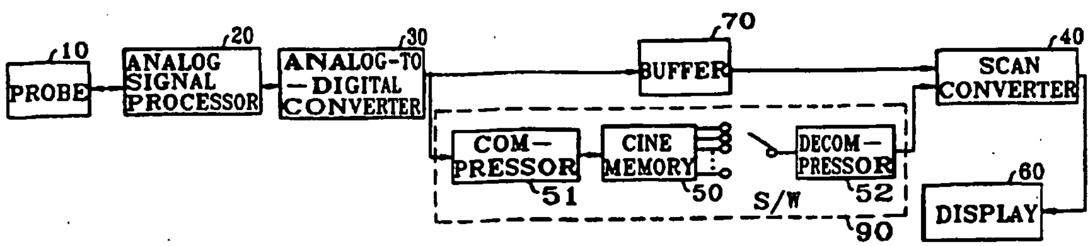
(81) Designated States: JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: ULTRASONIC DIAGNOSTIC APPARATUS FOR COMPRESSING AND STORING DATA IN CINE MEMORY



(57) Abstract

A efficient ultrasonic diagnostic apparatus for compressing and storing data in a CINE memory (50) is provided, which uses an LZW algorithm to compress and decompress the data. In embodying this LZW method to compress and decompress the data, there are two methods such as a hardware implementation method on an integrated circuit chip using a content addressable memory (45) and a software implementation method using a program stored in a microprocessor (80) in a microprocessor-based ultrasonic diagnostic apparatus.

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ULTRASONIC DIAGNOSTIC APPARATUS FOR COMPRESSING AND STORING DATA IN CINE MEMORY

TECHNICAL FIELD

The present invention relates to an ultrasonic diagnostic apparatus using a CINE memory, and more particularly to an ultrasonic diagnostic apparatus for compressing and storing data in a CINE memory.

BACKGROUND ART

Generally, an ultrasonic diagnostic apparatus using a CINE memory stores data containing image information in the CINE memory composed of several banks by time and reads the data of a desired time from the CINE memory to reproduce the read data.

A conventional ultrasonic diagnostic apparatus using a CINE memory did not adopt a data compression technique. As a result, an efficiency between data stored in a CINE memory and the CINE memory deteriorates. Accordingly, the cost of the CINE memory can cause a problem.

DISCLOSURE OF INVENTION

To solve the above problems, it is an object of the present invention to provide an ultrasonic diagnostic apparatus for compressing and storing data in a CINE memory, and decompressing and reproducing the data when the compressed data is read from the CINE memory, thereby effectively using the CINE memory and saving a cost.

To accomplish the above object of the present invention, there is

provided an ultrasonic diagnostic apparatus for compressing and storing data in a CINE memory, and decompressing and reproducing the data, which uses a LZW (Lempel-Ziv–Welch) method. In embodying this LZW method, there are two methods such as a hardware implementation method on an integrated circuit (IC) chip using a content addressable memory (CAM) and a software implementation method using a program stored in a microprocessor in a microprocessor-based ultrasonic diagnostic apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a conventional ultrasonic diagnostic apparatus using a CINE memory such as a video RAM (VRAM).

FIG. 2 is a block diagram of a conventional ultrasonic diagnostic apparatus using a CINE memory such as a dynamic RAM (DRAM).

FIG. 3 is a block diagram of an ultrasonic diagnostic apparatus using a CINE memory in which data is compressed and stored by hardware implementation.

FIG. 4 is a block diagram of the compressor and the decompressor shown in FIG. 3.

FIG. 5 is a block diagram of a microprocessor-based ultrasonic diagnostic apparatus using a CINE memory in which data is compressed and stored by a software program stored in a microprocessor.

BEST MODE FOR CARRYING OUT THE INVENTION

Prior to describing the present invention, a conventional ultrasonic diagnostic apparatus using a CINE memory will be described below with reference to FIG. 1.

As shown in FIG. 1, an ultrasonic diagnostic apparatus using a

CINE memory stores image data to be displayed after completion of scan conversion. Accordingly, the CINE memory should use a VRAM.

An electrical signal supplied from a probe 10 is processed in an analog signal processor 20 having a transmitter, a receiver, a beam former, a dynamic filter and a TGC, and then is converted into a digital signal in an analog-to-digital converter 30. Then, the digital signal is converted into a proper scan direction to be displayed by a scan converter 40.

The image data whose scan direction has been changed by the scan converter 40 is displayed on a display screen 60 and simultaneously stored in a CINE memory 50.

The image data stored in the CINE memory 50 can be reproduced and displayed in the display 50 by a CINE bank selected by a switch portion S/W.

That is, a general ultrasonic diagnostic apparatus using a CINE memory displays images with respect to a texture and a blood stream on a screen and stores the image data in the CINE memory, and reproduces the data stored in the CINE memory not direct scanning data and displays the reproduced data on the screen.

When the scan-converted data is stored in the CINE memory as in the conventional agnostic apparatus using a CINE memory shown in FIG. 1, the image data has a size of 512x512 per one frame, that is, 256KBytes in size. Accordingly, to store 64 frames of image data requires a large-capacity memory of 16MBytes. Thus, a VRAM for storing image data should be used, which causes higher cost.

FIG. 2 is a block diagram of a conventional ultrasonic diagnostic apparatus using a CINE memory such as a dynamic RAM (DRAM). The ultrasonic diagnostic apparatus shown in FIG. 2 stores analog-to-digital converted data in the CINE memory before scan-conversion differently from the FIG. 1 ultrasonic diagnostic apparatus, in which a DRAM is used as the CINE memory.

Data is stored in units of a frame in the CINE memory 50 and is reproduced therefrom. When the CINE memory 50 is located in front of the scan converter 40 as shown in FIG. 2, the scan converter 40 receives data in units of one frame, which requires accordingly a buffer portion 70 for storing the analog-to-digital converted data for a period of one frame.

Meanwhile, since the analog-to-digital converted data is 256x512 Bytes, that is, 128KBytes per a frame in size, or 128x512Bytes, that is, 64KBytes, a memory capacity is reduced into a half or a quarter that of the ultrasonic diagnostic apparatus of FIG. 1 for storing the scan-converted image data. Also, since the DRAM is used instead of the VRAM, the cost is saved.

However, the conventional ultrasonic diagnostic apparatus using a CINE memory such as a DRAM does not adopt a data compression technique in order to compress and store the data in the CINE memory, to accordingly lower an efficiency. This is because it is not possible to perform a real-time processing in compressing and storing the data in the CINE memory and decompressing and reproducing the data therefrom.

The present invention uses a compression technique capable of performing a real-time processing, compresses and stores the data in the CINE memory, and decompresses and reproduces the data during reproducing, to thereby provide an efficient ultrasonic diagnostic apparatus.

Also, the present invention provides a hardware implementation and a software implementation using a microprocessor, in order to compress and store data.

Hereinbelow, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

FIG. 3 is a block diagram of an ultrasonic diagnostic apparatus using a CINE memory in which data is compressed and stored by

hardware implementation.

In this embodiment of FIG. 3, data is stored in the CINE memory before scan-conversion of the data to save cost, which results in use of a DRAM as the CINE memory.

An electrical signal supplied from a probe 10 is processed in an analog signal processor 20 having a transmitter, a receiver, a beam former, a dynamic filter and a TGC, and then is converted into a digital signal in an analog-to-digital converter 30. Then, the digital signal is compressed by a compressor 51 and stored in the CINE memory 50.

The compressed and stored data is reproduced from a CINE bank selected by selection of a switch portion S/W and passes through a decompressor 52 for decompressing the compressed data whose scan direction is changed by the scan converter 40 to then be displayed on a display screen 60.

As shown in FIG. 3, a CINE memory portion 90 compresses and stores the data therein and decompresses and reproduces the data, which includes a compressor 51 for compressing the data in the CINE memory and a decompressor 52 for decompressing the compressed data therefrom.

Meanwhile, the data which is not stored in the CINE memory 50 is transferred to the scan converter 40 in units of one frame via the buffer portion 70. The scan direction of the data is changed by the scan converter 40, to then be displayed immediately.

There are various methods for compressing and storing the data in the CINE memory, and decompressing and reproducing the data therefrom, on a real-time basis.

The present invention uses a data compression and decompression method by an LZW algorithm.

The Lempel-Ziv algorithm is modified and supplemented by Welch to produce the LZW algorithm by which data compression is

accomplished by using repetitive data patterns, which will be detailed below.

It is assumed that a string of a variable length exists on a successive bitstream. It is checked whether or not a string of an assumed length repeats. Then, a non-repeated, fundamental string is stored in a table and a repetitive string is mapped and coded as an address on the table.

Thus, when repetition of a pattern is little and the pattern is randomly distributed, a compression effect by the LZW algorithm is not large, while image data has a high compression rate due to many repetitive bitstreams.

In the ultrasonic diagnostic apparatus, the analog-to-digital converted data is compressed into a half to a fifth averagely by the LZW algorithm.

The LZW algorithm is also used to decompress the compressed data, in which case a string corresponding to addresses of a coded table within the compressed data is substituted with reference to the table.

In the present invention, the above-described LZW algorithm can be embodied in hardware using the compressor 51 and the decompressor 52 shown in FIG. 3. FIG. 4 is a block diagram of the compressor and the decompressor in FIG. 3. To embody the LZW algorithm in hardware, a CAM (content addressable memory) manufactured by MUSIC Semiconductor Company Limited is used. The tables in the LZW algorithm are stored in and read from the CAM, by which a real-time processing of the LZW algorithm becomes possible.

Firstly, a data compression procedure will be described with reference to FIG. 4.

An input portion 41 receives two 8-bit data signals and outputs one 16-bit data signal. A comparison latch portion 42 delays the

16-bit data and outputs the delayed 16-bit data to a comparator 43 and a buffer 48. The comparator 43 compares the signal output from the comparison latch portion 42 with the signal output from the buffer 48, and outputs the comparison result to a controller 44. The controller 44 determines the contents of tables to be stored in the CAM 45 according to the comparison result and outputs the determined table contents to the CAM 45.

Referring to FIG. 4, a data decompression is accomplished in such a manner that the controller 44 refers to the tables stored in the CAM 45 and operates to restore the compressed data in original data, to thereby output the restored data via an output portion 41A.

A programmable ROM (PROM) 46 stores variables of the LZW algorithm and a static RAM (SRAM) 47 stores data representing compression procedures.

A variable increasing portion 49 increases variables and supplies the increased variables to the controller 44. An address generator 46A generates addresses under control of the controller 44 and reads the stored variables from the PROM 46. The controller 44 controls each element of the FIG. 4 compressor and decompressor.

When the LZW algorithm is embodied in hardware using the CAM, the data compression and decompression is accomplished separately from the scan converter 40.

FIG. 5 is a block diagram of a microprocessor-based ultrasonic diagnostic apparatus using a CINE memory in which data is compressed and stored by a software program stored in a microprocessor.

In FIG. 5, a microprocessor 80 is adopted to compress data using an LZW algorithm stored in the microprocessor 80, and stores the compressed data in the CINE memory 50, and decompresses and reproduces the data stored in the CINE memory 50 using the program stored in the microprocessor 80.

When data is compressed and decompressed using the microprocessor 80, a scan-conversion operation can be performed using the program stored in the microprocessor 80, which does not need a scan converter any more.

Also, a microprocessor-based ultrasonic diagnostic apparatus has a buffer portion 70 having two buffers, in which analog-to-digital converted data in correspondence to one frame capacity is read via a first buffer and simultaneously data in correspondence to one frame capacity is stored via a second buffer.

In case of using the CINE memory having a capacity of 16MBytes, the number of the frames to be stored will follow.

The number of frames to be stored in CINE memory of 16MBytes is (a) 64 in case that a VRAM is used as shown in FIG. 1, (b) 128 to 256 in case that a DRAM is used as shown in FIG. 2, and (c) 256 to 1280 in case that data is compressed and decompressed using an LZW algorithm as shown in FIGs. 3 and 5.

INDUSTRIAL APPLICABILITY

As described above, the present invention can be used in an ultrasonic diagnostic apparatus adopting a technique for compressing and storing data in a CINE memory using an LZW algorithm. Accordingly, the CINE memory can be effectively used when data is compressed and stored using the LZW algorithm.

WHAT IS CLAIMED IS:

1. An ultrasonic diagnostic apparatus using a CINE memory (50) characterized in that data is compressed and stored in said CINE memory (50), and the data is decompressed and reproduced from said CINE memory (50).

2. The ultrasonic diagnostic apparatus using a CINE memory (50) according to claim 1, further comprising a content addressable memory (CAM) (45), which uses an LZW (Lempel-Ziv-Welch) algorithm to compress and decompress the data.

3. The ultrasonic diagnostic apparatus using a CINE memory (50) according to claim 1, further comprising a microprocessor (80) for performing a program of compressing and storing the data in said CINE memory (50) and a scan direction conversion.

4. The ultrasonic diagnostic apparatus using a CINE memory (50) according to claim 3, wherein said program for compressing and decompressing the data in said microprocessor (80) is based on the LZW algorithm.

FIG. 1

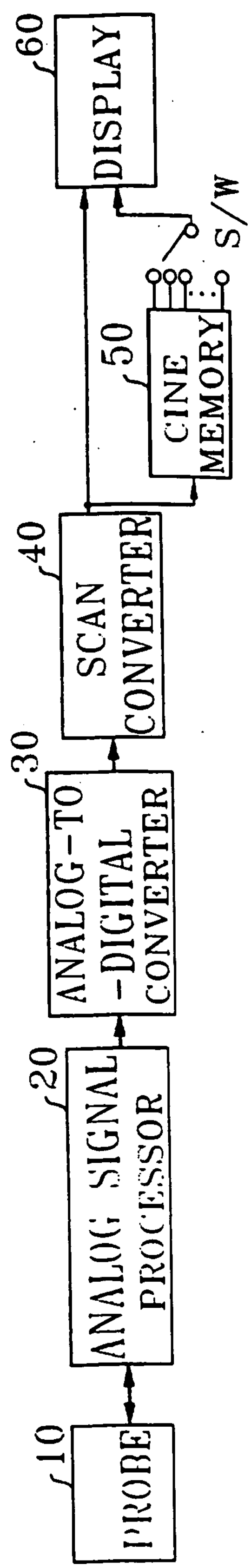

PROBE
10
ANALOG SIGNAL PROCESSOR
20
ANALOG-TO-DIGITAL CONVERTER
30
SCAN CONVERTER
40
CINE MEMORY
50
S/W
DISPLAY
60

FIG. 2

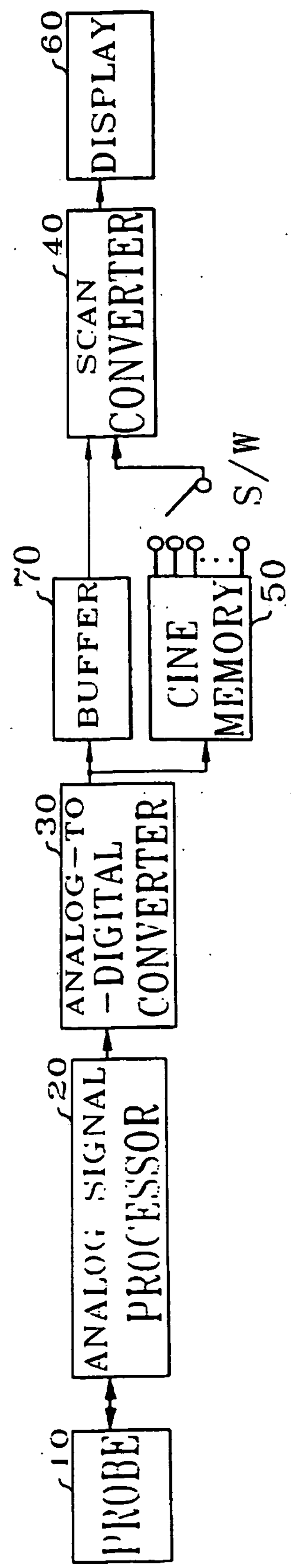

PROBE
10
ANALOG SIGNAL PROCESSOR
20
ANALOG-TO-DIGITAL CONVERTER
30
BUFFER
70
CINE MEMORY
50
S/W
SCAN CONVERTER
40
DISPLAY
60

FIG. 3

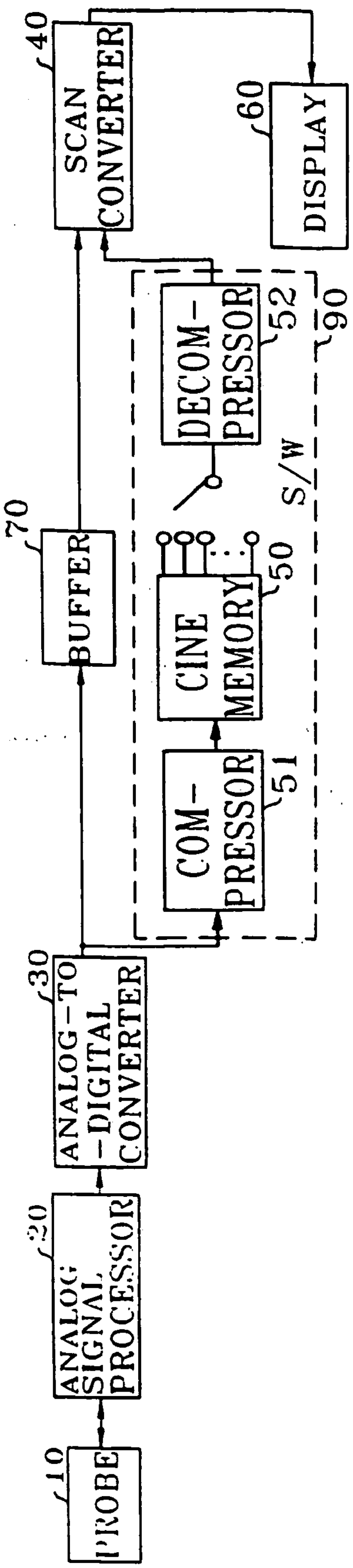

PROBE
10
ANALOG SIGNAL PROCESSOR
20
ANALOG-TO-DIGITAL CONVERTER
30
BUFFER
70
SCAN CONVERTER
40
DISPLAY
60
COM-PRESSOR
51
CINE MEMORY
50
S/W
DECOM-PRESSOR
52
90

FIG. 4

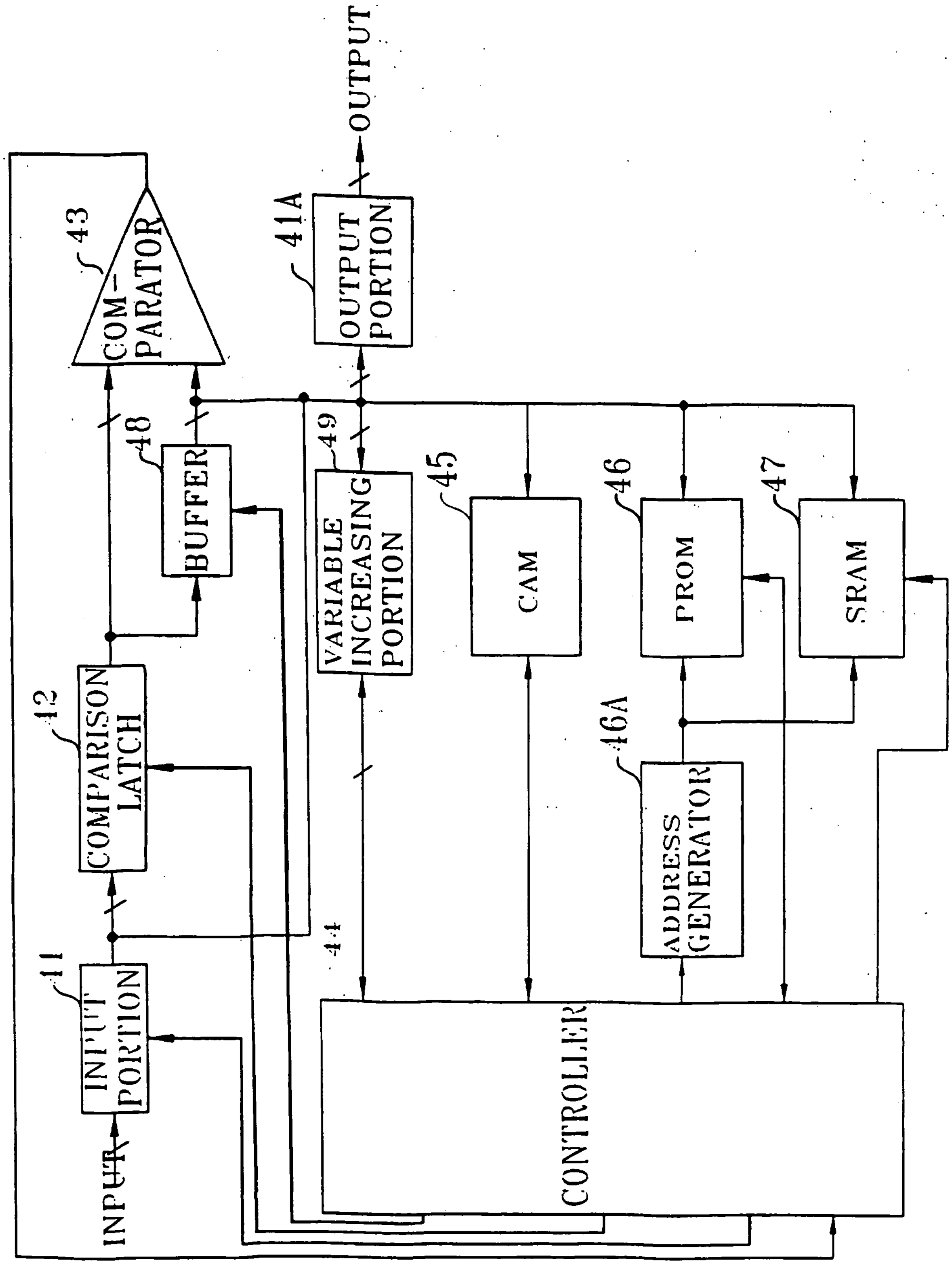
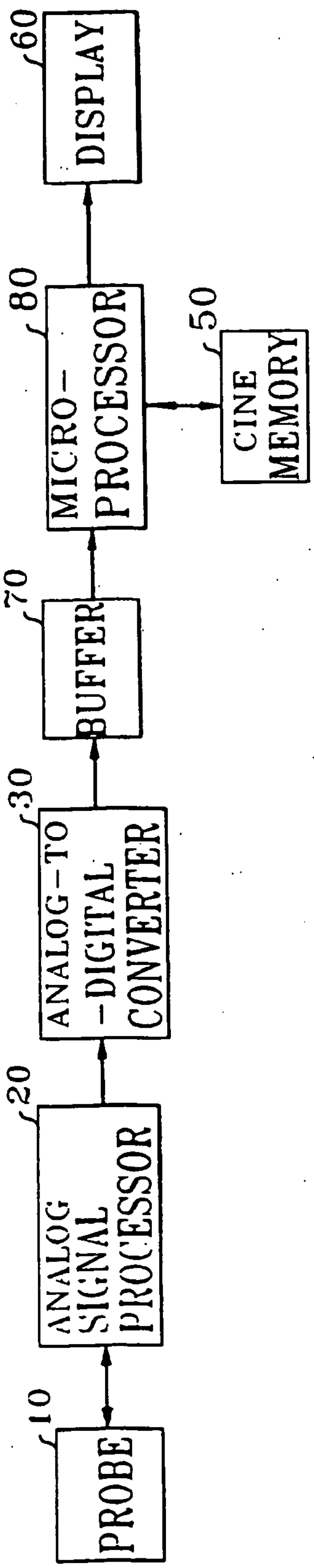

INPUT
INPUT PORTION
COMPARISON LATCH
42
BUFFER
48
COM-PARATOR
43
OUTPUT PORTION
41A
OUTPUT
VARIABLE INCREASING PORTION
49
CAM
45
PROM
46
SRAM
47
ADDRESS GENERATOR
46A
CONTROLLER
44

FIG. 5


PROBE
10
ANALOG SIGNAL PROCESSOR
20
ANALOG-TO -DIGITAL CONVERTER
30
BUFFER
70
MICRO-PROCESSOR
80
CINE MEMORY
50
DISPLAY
60

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 96/00157

A. CLASSIFICATION OF SUBJECT MATTER

IPC[6]: A 61 B 8/00; H 03 M 7/30

According to International Patent Classification (IPC) or to both national classification and IPC

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Minimum documentation searched (classification system followed by classification symbols)

IPC[6]: A 61 B; H 03 M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPOQUE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,E	EP 0 734 126 A1 (INTERNATIONAL BUSINESS MACHINES CORP.) 25 September 1996 (25.09.96), abstract; claims 4,10,12.	1,2,3,4
Y	EP 0 370 654 A2 (PICKER) 30 May 1990 (30.05.90), abstract; column 1, line 1 - column 3, line 36; fig.1.	1,2,3,4
Y	US 5 412 429 A (GLOVER) 02 May 1995 (02.05.95), abstract; fig.1,2; column 1, line 1 - column 2, line 26.	1,4
Y,P	EP 0 702 457 A2 (INTERNATIONAL BUSINESS MACHINES CORP.) 20 March 1996 (20.03.96), abstract; page 1, lines 1-10; page 2, lines 19,20.	

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search
22 November 1996 (22.11.96)

Date of mailing of the international search report
09 December 1996 (09.12.96)

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EP A1 734126	25-09-96	JP A2 8275000	18-10-96
EP A2 370654	30-05-90	DE C0 68922187	18-05-95
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		EP A3 370654	10-07-91
		EP A3 370654	27-11-91
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US A 5412429	02-05-95	keine - none - rien	
EP A2 702457	20-03-96	JP A2 8079092	22-03-96
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